

WHAT IS CLAIMED IS:

1. A single-ply absorbent sheet provided with primary undulations extending  
5 along a principal undulatory axis of said sheet, said primary undulations  
being laterally spaced apart a distance, S, said single-ply absorbent sheet  
being provided with an emboss pattern comprising a plurality of design  
elements wherein up to about 50 percent of the surface area of said  
absorbent sheet is embossed, characterized in that each design element of  
10 said emboss pattern has a characteristic emboss element lateral width, W,  
and a characteristic emboss element, length, L, along a direction L' and  
wherein the ratio of W:S for each design element is from about 1 to about  
4.
- 15 2. The single-ply absorbent sheet according to Claim 1, wherein the ratio of  
W:S for each design element is from about 1.5 to about 3.
3. The single-ply absorbent sheet according to Claim 1, wherein the aspect  
ratio, L:W for each design element is at least about 1.1.
- 20 4. The single-ply absorbent sheet according to Claim 1, wherein the aspect  
ratio, L:W for each design element is at least about 1.2.
5. The single-ply absorbent sheet according to Claim 1, wherein the aspect  
25 ratio, L:W for each design element is from about 1.1 to about 4.
6. The single-ply absorbent sheet according to Claim 1, wherein the aspect  
ratio, L:W for each design element is from about 1.2 to about 2.5.

7. The single-ply absorbent towel according to Claim 1, wherein said direction, L', makes an angle  $\theta$  of less than about 45 degrees with the principal undulatory axis of said sheet.
- 5 8. The single-ply absorbent sheet according to Claim 7, wherein said direction, L', makes an angle  $\theta$  of less than about 30 degrees with the principal undulatory axis of said sheet.
9. The single-ply absorbent sheet according to Claim 1, wherein the aspect  
10 ratio, L:W for each design element is about 1.
10. The single-ply absorbent sheet according to Claim 1, wherein said sheet is provided with secondary undulations substantially perpendicular to said primary undulations such that said sheet is a biaxially undulatory sheet  
15 with secondary undulations extending along a secondary undulatory axis of said sheet.
11. The single-ply absorbent sheet according to Claim 10, wherein said sheet has from about 10 to about 50 primary undulations per inch extending  
20 along said principal undulatory axis and from about 10 to about 150 secondary undulations per inch extending along said secondary undulatory axis of said sheet.
12. The single-ply absorbent sheet according to Claim 11, wherein said sheet  
25 has from about 12 to about 25 primary undulations extending along said principal undulatory axis of said sheet.
13. The single-ply absorbent sheet according to Claim 10, wherein said secondary undulations have a frequency greater than that of said primary  
30 undulations.

14. The single-ply absorbent sheet according to Claim 1, wherein said sheet is a creped sheet and wherein said primary undulations extend in the machine direction of said sheet and are longitudinally extending undulations.
- 5 15. The single-ply absorbent sheet according to Claim 14, wherein said sheet has from about 10 to about 150 crepe bars per inch extending in the cross-direction of said sheet.
- 10 16. The single-ply absorbent sheet according to Claim 15, prepared with an undulatory creping blade operative to form said longitudinally extending undulations.
- 15 17. The single-ply absorbent sheet according to Claim 16, wherein said sheet has from about 10 to about 50 longitudinally extending undulations per inch.
- 20 18. The single-ply absorbent sheet according to Claim 17, wherein said sheet has from about 12 to about 25 longitudinally extending undulations per inch.
- 25 19. The single-ply absorbent sheet according to Claim 16, wherein the crepe bars have a frequency greater than that of the longitudinally extending undulations.
- 30 20. The single-ply absorbent sheet according to Claim 19, wherein the frequency of the crepe bars is from about 2 to about 6 times the frequency of said longitudinally extending undulations.
21. The single-ply absorbent sheet according to Claim 20, wherein the frequency of the crepe bars is from about 2 to about 4 times the frequency of said longitudinally extending undulations.

22. The single-ply absorbent sheet according to Claim 14, wherein the emboss pattern does not substantially alter the cross-direction stretch of the absorbent sheet from which the embossed absorbent sheet was prepared.
- 5 23. The single-ply absorbent sheet according to Claim 22, wherein the cross-direction stretch of said sheet is from about 0.2 to about 0.8 times the machine direction stretch of said sheet.
24. The single-ply absorbent sheet according to Claim 23, wherein the  
10 cross-direction stretch of said sheet is from about 0.35 to about 0.8 times the machine direction stretch of said sheet.
25. The single-ply absorbent sheet according to Claim 1, wherein the distance between design elements, D, is greater than S.
- 15 26. The single-ply absorbent sheet according to Claim 25, wherein D is from about 1.5 to about 3 times S.
27. The single-ply absorbent sheet according to Claim 1, wherein said design  
20 elements have an emboss depth of from about 15 to about 30 mils.
28. The single-ply absorbent sheet according to Claim 1, wherein from about 10 to about 25 percent of the surface area of said sheet is embossed.
- 25 29. The single-ply absorbent sheet according to Claim 1, wherein said sheet is a tissue product having a basis weight of from about 5 to about 25 pounds per 3,000 square foot ream.
- 30 30. The single-ply absorbent sheet according to Claim 1, wherein said sheet is a towel product having a basis weight of from about 10 to about 40 pounds per 3,000 square foot ream.

31. The single-ply absorbent sheet according to Claim 1 prepared utilizing recycle furnish.
32. A single-ply sheet provided with primary undulations extending along a principal axis of said sheet, said primary undulations being laterally spaced apart a distance, S, said single-ply absorbent sheet being further provided with an emboss pattern comprising a plurality of embossments of width, W, and length, L, wherein the lengths are along a direction, L', and wherein said embossments cover no more than about fifty percent of the area of said absorbent sheet, and wherein further the embossments are spaced apart from each other at a distance, D, with the proviso that at least one of the ratios of W:S and D:S is from about 1 to about 4.
33. The single-ply absorbent sheet according to Claim 32, wherein at least one of the ratios of W:S and D:S is from about 1.5 to about 3.5.
34. The single-ply absorbent sheet according to Claim 32, wherein said embossments cover no more than about 25 percent of the surface area of said sheet.
35. The single-ply absorbent sheet according to Claim 32 wherein the ratio of cross-direction stretch to machine direction stretch is from about 0.2 to about 0.8.
36. The single-ply absorbent sheet according to Claim 35, wherein the ratio of the cross-direction stretch to the machine direction stretch is from about 0.35 to about 0.8.
37. The single-ply absorbent sheet according to Claim 32, wherein said principal undulatory axis is along the machine direction of said sheet.

38. The single-ply embossed sheet according to Claim 32, wherein said primary undulations are non-compacted relative to the other portions of the sheet.
- 5 39. A method of making a single-ply absorbent sheet comprising:
- preparing a web comprising cellulosic furnish;
- drying the web to form said absorbent sheet;
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- providing said sheet with primary undulations extending along a principal undulatory axis of the absorbent sheet, said undulations being spaced apart a distance, S; and
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- embossing the sheet with an emboss pattern comprising a plurality of design elements wherein up to about 50 percent of the surface area of said sheet is embossed, characterized in that each design element of said emboss pattern has a characteristic emboss element width, W, and a characteristic emboss length, L, along a direction, L', and wherein the ratio
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- of W:S for each design element is from about 1 to about 4.
40. The method according to Claim 39, wherein said sheet is dried to a consistency of at least 90 percent prior to being embossed.
- 25 41. The method according to Claim 39, wherein said sheet is embossed at a consistency of less than about 90 percent.
42. The method according to Claim 39, wherein said absorbent sheet is provided with said primary undulations by way of wet shaping said sheet
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- on a fabric.

43. The method according to Claim 42, wherein said step of wet shaping said sheet on a fabric is carried out at a consistency of between about 30 and about 85 percent.
- 5 44. The method according to Claim 39, wherein said sheet is a biaxially undulatory sheet with secondary undulations extending in a direction substantially perpendicular to said principal undulatory axis.
45. The method according to Claim 44, wherein said sheet includes applying  
10 said sheet to a Yankee dryer and wherein said sheet is creped from said Yankee dryer.
46. The method according to Claim 39, wherein the ratio of W:S for each design element is from about 1.5 to about 3.
- 15 47. The method according to Claim 39, wherein the aspect ratio, L:W for each design element is at least about 1.1.
48. The method according to Claim 39, wherein the aspect ratio, L:W for each  
20 design element is at least about 1.2.
49. The method according to Claim 47, wherein the aspect ratio, L:W for each design element is from about 1.1 to about 4.
- 25 50. The method according to Claim 39, wherein the aspect ratio, L:W for each design element is from about 1.2 to about 2.5.
51. The method according to Claim 39, wherein said direction, L', makes an  
30 angle  $\theta$  of less than about 45 degrees with the machine direction of said sheet.

52. The method according to Claim 51, wherein said direction, L', makes an angle  $\theta$  of less than about 30 degrees with the machine direction of said sheet.

5 53. The method according to Claim 39, wherein the aspect ratio, L:W for each design element is about 1.

54. A method of making a single-ply embossed absorbent sheet comprising:

10 preparing a web comprising cellulosic furnish;

applying said web to a Yankee dryer;

15 creping said web from said Yankee dryer with an undulatory creping blade at a consistency of between about 40 and about 98 percent, such that said creped sheet is provided with crepe bars extending laterally in the cross-direction and undulations extending longitudinally in the machine direction, said undulations being spaced apart a distance, S; and

20 embossing said sheet with an emboss pattern comprising a plurality of design elements wherein up to about 50 percent of the surface area of said absorbent sheet is embossed, characterized in that each design element of said emboss pattern has a characteristic emboss element lateral width, W, and a characteristic emboss element, length, L, along a direction  
25 L' and wherein the ratio of W:S for each design element is from about 1 to about 4.

55. The method according to Claim 54, wherein said step of embossing said absorbent sheet comprises passing said sheet through a nip defined by a  
30 pair of matched embossing rolls.



56. The method according to Claim 55, wherein said matched embossing rolls are rigid embossing rolls.
57. The method according to Claim 56, wherein said rigid embossing rolls are steel embossing rolls.
58. The method according to Claim 55, wherein said matched embossing rolls include a rigid roll and a yielding roll.
59. The method according to Claim 58, wherein said rigid roll is a steel embossing roll and said yielding embossing roll is a rubber embossing roll.
60. The method according to Claim 54, wherein the ratio of W:S for each design element is from about 1.5 to about 3.
61. The method according to Claim 54, wherein the aspect ratio, L:W for each design element is at least about 1.1.
62. The method according to Claim 54, wherein the aspect ratio, L:W for each design element is at least about 1.2.
63. The method according to Claim 61, wherein the aspect ratio, L:W for each design element is from about 1.1 to about 4.
64. The method according to Claim 54, wherein the aspect ratio, L:W for each design element is from about 1.2 to about 2.5.
65. The method according to Claim 54, wherein said direction, L', makes an angle  $\theta$  of less than about 45 degrees with the machine direction of said sheet.

66. The method according to Claim 65, wherein said direction, L', makes an angle  $\theta$  of less than about 30 degrees with the machine direction of said sheet.
- 5 67. The method according to Claim 54, wherein the aspect ratio, L:W for each design element is about 1.
68. The method according to Claim 54, wherein said sheet has from about 10 to about 150 crepe bars per inch extending in the cross-direction of said  
10 sheet.
69. The method according to Claim 68, wherein said sheet has from about 10 to about 50 longitudinally extending undulations per inch.
- 15 70. The method according to Claim 69, wherein said sheet has from about 12 to about 25 longitudinally extending undulations per inch.
71. The method according to Claim 54, wherein the crepe bars have a frequency greater than that of the longitudinally extending undulations.  
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72. The method according to Claim 71, wherein the frequency of the crepe bars is from about 2 to about 6 times the frequency of said longitudinally extending undulations.
- 25 73. The method according to Claim 72, wherein the frequency of the crepe bars is from about 2 to about 4 times the frequency of said longitudinally extending undulations.
74. The method according to Claim 54, wherein the emboss pattern does not  
30 substantially alter the cross-direction stretch of the absorbent sheet from which the embossed absorbent sheet was prepared.

75. The method according to Claim 54, wherein the cross-direction stretch of said sheet is from about 0.2 to about 0.8 times the machine direction stretch of said sheet.
- 5 76. The method according to Claim 75, wherein the cross-direction stretch of said sheet is from about 0.35 to about 0.8 times the machine direction stretch of said sheet.
77. The method according to Claim 54, wherein the distance between design  
10 elements, D, is greater than S.
78. The method according to Claim 77, wherein D is from about 1.5 to about 3 times S.
- 15 79. The method according to Claim 54, wherein said design elements have an emboss depth of from about 15 to about 30 mils.
80. The method according to Claim 54, wherein from about 10 to about 25 percent of the surface area of said sheet is embossed.
- 20 81. The method according to Claim 54, wherein said sheet is a tissue product having a basis weight of from about 5 to about 25 pounds per 3,000 square foot ream.
- 25 82. The method according to Claim 54, wherein said sheet is a towel product having a basis weight of from about 10 to about 40 pounds per 3,000 square foot ream.
- 30 83. The method according to Claim 54, wherein said cellulosic furnish comprises recycle furnish.

84. The method according to Claim 54, wherein said cellulosic furnish comprises non-cellulosic material.
  85. The method according to Claim 54, wherein said cellulosic furnish comprises synthetic fiber.
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